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WI \_\_\_\_\_ 260100.02 \_\_\_\_\_

T \_\_\_\_\_ 526 \_\_\_\_\_

BALLOT NO. \_\_\_\_\_ 03 SARG \_\_\_\_\_

DRAFT NO. \_\_\_\_\_ 01 \_\_\_\_\_

DATE \_\_\_\_\_ November 3, 2026 \_\_\_\_\_

WORKING GROUP  
CHAIR \_\_\_\_\_ N/A \_\_\_\_\_

SUBJECT  
CATEGORY \_\_\_\_\_ Coating and Graphic Arts \_\_\_\_\_

RELATED  
METHODS \_\_\_\_\_ See "Additional Information" \_\_\_\_\_

**CAUTION:**

This Test Method may include safety precautions, which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals, which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Safety Data Sheets, which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

## **Blister Resistance of Coated Paper in Heatset Printing** *(Ten-year review of Classical Method T 526 cm-17)*

### **1. Scope and significance**

This method is used to measure the resistance of coated paper and coated board to blistering in the ovens of web-fed heatset printing presses. This objective is accomplished by applying lacquer to both sides of the paper to simulate printed ink films and placing the lacquered samples in a blister tester in which both temperature and exposure time can be varied widely and reproducibly. The heat exposure simulates the action of the heatset oven. End points obtained may be compared with other test results.

### **2. Summary**

Lacquer is applied to both sides of a paper sample from which specimen strips are cut. The strips are mounted in holders, one to each holder, and passed between the heating elements of the tester. As temperature level and/or specimen exposure time is increased, the forces of vapor pressure within the paper increase until blistering occurs. A blister resistance level is determined.

### 3. Definition

*Blister resistance* is that property of paper which withstands the vapor pressure generated internally in rapid heating of paper and allows that pressure to leak away through the combined coating and ink layers.

### 4. Apparatus

4.1 *Lacquer drawdown apparatus*, consisting of the following:

4.1.1 *Drawdown block*, a piece of plate glass or the equivalent approximately  $250 \times 30 \times 13$  mm (approximately  $10 \times 12 \times 0.5$  in.) with a flat top surface.

4.1.2 *Holding device*, a weight, approximately 1000 g, or a clamp to hold the sample in place on the drawdown block.

4.1.3 *Drawdown rod*, a No. 8 Mayer wire-wound rod 6.35 mm (0.25 in.) diameter.

4.1.4 *Drawdown rod cleaning and soaking bath*, a piece of glass tubing about 13 mm (about 0.5 in.) diameter, sealed and padded at the bottom end, clamped in an upright position and of sufficient height to allow total immersion of the wound portion of the drawdown rod in solvent.

4.2 *Heat exposure apparatus (blister tester)*. The tester (see Fig. 1, which shows the door open for clarity) is operated with the door closed and consists of the following major components:

4.2.1 *Oven*, two banks of quartz tubes mounted in reflectors and facing each other across a vertical gap.

4.2.2 *Specimen transporter*, a three-layer metal fabrication with a slot to receive specimen holders and a window to permit exposure of both sides to oven heat. The transporter is mounted on a horizontal shaft, about which it revolves, passing through the oven gap.

4.2.3 *Transporter drive*, a direct current gear motor, supplied by a solid-state variable direct current supply for controlling motor speed.

4.2.4 *Millisecond timer*, an instrument which senses and indicates actual oven dwell time for each movement of the transporter with an accuracy of  $\pm 0.02$  s.

4.2.5 *Variable transformer*, a 7200-W auto-transformer which can adjust oven heater voltage between zero and 240 V. Oven voltage is indicated by a voltmeter.

4.2.6 *Temperature controller*, a solid-state controller with two set points adapted to switch on the oven heater when the gap has cooled to the lower set point and to start transporter movement when the gap has warmed to the higher set point.

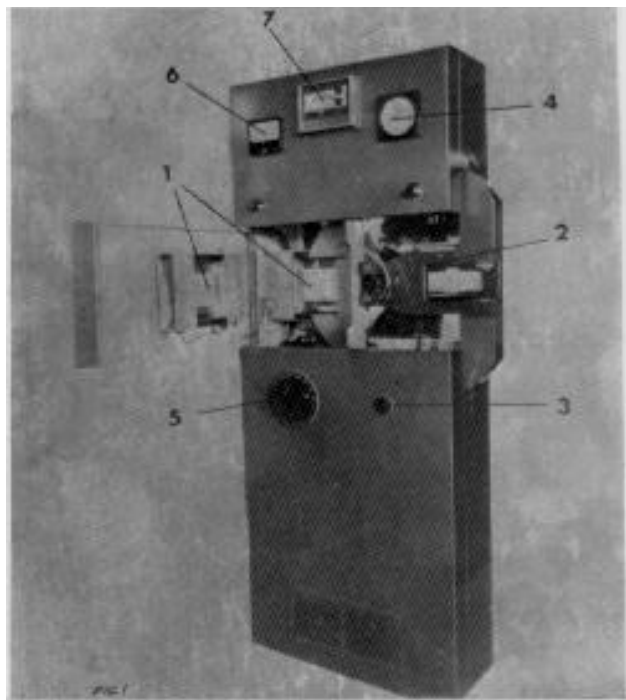


**Fig. 1.** Blister tester: 1, oven; 2, specimen transporter; 3, variable direct current supply; 4, millisecond timer; 5, variable transformer; 6, alternating current voltmeter; 7, temperature controller.

## 5. Materials

5.1 *Blister testing drawdown lacquer*, comprised of 55 parts lacquer and 45 parts technical grade ethyl acetate by volume. It is contained in a squeeze bottle with a small diameter delivery tube which is sealed with a rubber policeman.

5.2 *Cleaning solvent for lacquer*, ethyl acetate is suitable.

5.3 *Lint free rags or paper towels*, for cleanup.

**NOTE 1:** Because of flammability, ethyl acetate should be used only in a well-ventilated room and should be kept away from open flame.

## 6. Sampling

6.1 *Initial preparation*

6.1.1 From each test unit of paper obtained in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard or Related Product,” cut samples approximately 220 × 280 mm (approximately 8½ × 11 in.), grain optional, free from wrinkles, creases, and other abnormalities. Handle the samples only by the edges to avoid contamination from fingerprints. Mark each sample to identify its origin and wire and felt sides. Smaller samples may be lacquered without affecting the validity of the test.

6.2 *Conditioning*

6.2.1 Condition the samples in an atmosphere in accordance with TAPPI T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products.” This test is affected by moisture hysteresis; therefore, precondition the samples so that equilibrium moisture is approached from the drier state.

**NOTE 2:** For routine control work, tests are made at the moisture content at time of manufacture without conditioning. This moisture content remains essentially unchanged until the paper is printed on a web-fed press.

**NOTE 3:** Conditioning is particularly important when comparing samples of different origin or different history.

6.3 *Lacquering*

6.3.1 Place a sample, felt side up, on the drawdown block, so the long sides are parallel to the right and left sides of the block and with the lower edge even with the near edge of the block. Place the weight (or clamp) on the sample at the center of the far edge of the block. Place the drawdown rod next to the weight (or clamp). Apply an excess of lacquer from the squeeze bottle in a line across the sample just in front of the rod. Place the thumbs on top of the rod just inside the edges of the block. Grasp the ends of the rod with the fingers. This method of holding the rod eliminates downward pressure on its ends which causes upward flexure of its center that would result in uneven lacquer application. Draw the rod forward in one even continuous motion over the near edge of the block onto waste paper to catch the excess lacquer. The drawdown movement should take approximately one-third of a second. Excess lacquer will be applied if the movement is too rapid. If the movement is too slow, excessive lacquer penetration will result on some papers. Allow at least 1 min for drying before proceeding to lacquer the wire side, following the same procedure.

6.3.2 Make sure that the rod is clean before each use. Several drawdowns may be made without cleaning the rod if the time between drawdowns is very short. Clean the rod when necessary by immersing it in the cleaning bath for a few seconds and then wiping it dry with a clean, lint-free rag or paper towel. After each use store the rod in the cleaning bath, ensuring that sufficient solvent is provided to cover the windings of the rod. The rod should always be thoroughly dried when removed from the bath, prior to making drawdowns.

6.3.3 Place the rubber policeman over the end of the delivery tube of the squeeze bottle when not in use to prevent leakage and drying of lacquer in the tip of the tube.

## 7. Preparation of blister tester

7.1 Adjust the temperature controller to the desired upper and lower set points (see Table 1 for reference settings). Some controllers require that the set point knobs be pressed and rotated until the needle reads desired temperature; other controllers are set by simply rotating the knobs without pressing in.

7.2 Turn on the oven by rotating the pushbutton to the “AUTO” position. While the oven is on, check, and adjust if necessary, the oven heater voltage by using the variable transformer knob and reading the voltmeter (see Table 1 for reference settings).

7.3 When the oven temperature rises to the upper set point, the sample transporter makes one complete revolution, stopping at the same position from which it started. When the transporter stops, the oven turns off. The oven then cools to the lower set point and again turns on, repeating the cycle. The cycle repeats until the pushbutton is released from the “AUTO” position.

**Table 1.** Blister tester: reference test conditions

| <i>Basis weight<sup>a</sup><br/>lb/ream, 25 x<br/>38 - 500<br/>(g/m<sup>2</sup>)</i> |         |     | <i>Temperature set points</i> |           |             |           |
|--------------------------------------------------------------------------------------|---------|-----|-------------------------------|-----------|-------------|-----------|
|                                                                                      |         |     | <i>Low</i>                    |           | <i>High</i> |           |
|                                                                                      |         |     | <i>°F</i>                     | <i>°C</i> | <i>°F</i>   | <i>°C</i> |
| 70                                                                                   | (103.6) | 120 | 440                           | 227       | 600         | 316       |
| 80                                                                                   | (118.4) | 128 | 480                           | 249       | 640         | 339       |
| 90                                                                                   | (133.2) | 136 | 525                           | 274       | 685         | 363       |
| 100                                                                                  | (148.0) | 144 | 570                           | 299       | 730         | 377       |
| 110                                                                                  | (162.8) | 152 | 610                           | 321       | 770         | 410       |
| 120                                                                                  | (177.6) | 158 | 655                           | 346       | 815         | 435       |
| 130                                                                                  | (192.4) | 167 | 700                           | 371       | 860         | 460       |
| 140                                                                                  | (207.2) | 175 | 740                           | 393       | 900         | 482       |

<sup>a</sup>Test conditions indicated for paper with basis weight of 80 lb/ream (118.4 g/m<sup>2</sup>) and above are based on limited experience.

7.4 The millisecond timer indicates the actual oven dwell time,  $\pm 0.02$  s for each revolution of the sample transporter. The timer is automatically reset to zero immediately after the start of the next transporter movement. If necessary, adjust the dwell time to the desired value using the control knob of the variable direct current supply (see Table 2 for reference dwell times).

**Table 2.** Oven dwell times for different graduated tests

| <i>Test number</i> | <i>Oven dwell time, s</i> |
|--------------------|---------------------------|
| 1                  | 1.1                       |
| 2                  | 1.0                       |
| 3                  | 0.9                       |
| 4                  | 0.8                       |
| 5                  | 0.7                       |
| 6                  | 0.6                       |
| 7                  | 0.5                       |
| 8                  | 0.4                       |

7.5 The pushbutton should remain in the “AUTO” position until samples are ready for test. It is best to preheat the tester according to the above procedure while lacquering samples. The tester could complete at least five cycles before the first specimen is tested.

## 8. Test specimens

Cut each lacquered sample into five 38 × 280 mm (1.5 × 11 in.) specimen strips, parallel to the drawdown direction, after first removing about 6 mm (about 0.25 in.) from each longer edge.

## 9. Procedure

9.1 Place one strip from each drawdown into a specimen holder. Do not place more than one strip in each holder.

9.2 Release the pushbutton from the “AUTO” position. Insert one holder, with specimen, into the slot in the transporter, pressing it in firmly until a “click” is heard. Press the pushbutton once. When the tester has completed its cycle, remove the tested strip and holder and insert the next strip and holder. Press the pushbutton again. Repeat this procedure until all specimen strips have been tested.

**NOTE 4:** Blister resistance of a particular paper sample is obtained by performing a series of tests on different sample specimens while varying oven dwell time. The dwell time reported is the longest oven dwell time which does not result in “roughening” or “blisters.”

9.3 Examine the tested specimen strips. They will appear smooth, roughened, or blistered (Fig. 2). Record these various conditions as “no blisters,” “roughening,” or “blisters” in such a manner that test parameters are included (a sample form for this purpose will be found on the last page of this method).



**Fig. 2.** Blister tested specimens; left to right: no blister, roughened, blisters.

## 10. Report

Report as the blister resistance rating the poorest test result from identical specimens.

## 11. Precision

11.1 *Repeatability* (within a laboratory) = within  $\pm 0.1$  s dwell time. This is based on the use of the tester in both routine control and product development testing in two separate laboratories over a year.

11.2 *Comparability* [between materials (paper)] = not known.

11.3 *Reproducibility* (between laboratories) =  $\pm 0.4$  s. This figure is based on average standard deviation of three samples in twelve laboratories.

11.4 The definitions of the above terms are in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility.”

11.5 Data relating to precision of this test were obtained in a round-robin testing program in which twelve laboratories cooperated. Each laboratory tested six different samples on each of two days and rechecked the end point reached on each sample each day. In the round-robin, the reference settings shown in Table 1 were used.

**NOTE 5:** Of the test results obtained in the round-robin of twelve laboratories and five samples (sixth sample was excluded due to high probability of mixed sample), 82% were within  $\pm 0.1$  s of the mean dwell time for blister point of that sample.

## 12. Keywords

Paperboard, Paper, Coated papers, Blistering, Heat set ink, Printing, Coated boards, Heat setting, Printing papers

## 13. Additional information

13.1 Effective date of issue: To be assigned.

13.2 This method, formerly T 526 su-72, has been reclassified as a Classical Method. Such procedures are no longer in common use or have been superseded by advanced technology; they are technically sound, have a history of use, and contain a body of literature references that make their preservation valuable.

13.3 In using Table 1 for reference apparatus settings, it should be pointed out that many combinations of settings of oven voltage, temperature controller set points, and oven dwell times are possible. As these settings are varied, the rate of specimen heating as well as maximum temperature to which specimens are exposed will vary widely and therefore influence test results.

*Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department.*

